MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF AERONAUTICS-STANDARD SPECIFICATION
D-705
Pipe Underdrains for Airports

Description

1.1 This item shall consist of pipe underdrains of the types, classes, sizes, and dimensions required on the plans, furnished and installed at the places designated on the plans and profiles, or by the engineer, in accordance with these specifications and with the lines and grades given.

The item shall include in the bid price per linear foot of pipe in place, the cost of geotextile wrap, the cost of excavation, the cost of furnishing and installing all trench bracing, all fittings required to complete the underdrain as shown on the plans, and the material for the making of all joints including all connections to existing drainage pipes and structures.

The bid price per linear foot of pipe shall include all backfill made with earth excavated from the immediate trench. When a granular backfill, as called for on the plans or as ordered by the Engineer, is used to replace material excavated from the trench, it **shall be bid and paid for separately as porous backfill No. 1 and/or No. 2, per cubic yard in place and compacted**.

MATERIALS

2.1 General. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements. Unless otherwise specified, pipe and tubing used for underdrains shall be perforated and shall be wrapped in geotextile. Where the drain outlets into an open ditch, or where otherwise required, a minimum of 10 feet of the pipe from the outlet end shall be unperforated pipe of any approved type. If jointed pipe is used, the pipe shall have sealed joints.

2.2 Vitrified Clay Cradle Invert Pipe. Vitrified clay cradle invert pipe shall meet the requirements of AASHTO M 65.

2.3 Perforated Vitrified Clay Pipe. Perforated vitrified clay pipe shall conform to the requirements of ASTM C700, except that nothing in the specifications shall exclude the use of plain end perforated clay pipe equipped with an approved type of joint fasteners. The fasteners shall be capable of maintaining the alignment of the pipe and securing a taut but elastic joint between the sections of pipe when laid. Fasteners may consist of wire clips or other devices which will produce a satisfactory joint. Pipe sizes of 12-inch and over shall be extra strength.

2.4 Perforated Concrete Pipe. Perforated concrete pipe shall conform to the requirements of ASTM C444.

2.5 Porous Concrete Pipe. Porous concrete pipe shall conform to the requirements of ASTM C654.

2.6 Perforated Corrugated Steel Pipe. Perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

2.7 Asbestos-Bonded, Perforated Corrugated Steel Pipe. Asbestos-bonded perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

2.8 Asphalt-Coated, Perforated Corrugated Steel Pipe. Asphalt-coated perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

2.9 Asphalt-Coated, Asbestos-Bonded, Perforated Corrugated.

(a) Steel pipe. Asphalt-coated, asbestos-bonded, perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

(b) **Perforated corrugated aluminum alloy pipe.** Perforated corrugated aluminum alloy pipe shall conform to the requirements of Fed. Spec. WW-P-402.

(c) **Asphalt-coated, perforated corrugated aluminum alloy pipe**. Asphalt-coated, perforated corrugated aluminum alloy pipe shall conform to the requirements of Fed. Spec. WW-P-402.

2.10 Bituminized-Fiber Pipe.

(a) Bituminous-fiber pipe and fittings for use as outfalls and connections to perforated pipe shall conform to the requirements of ASTM D-2311.

(b) Perforated bituminous-fiber pipe shall conform to the requirements of ASTM D-2311.

2.11 Perforated Asbestos-Cement Pipe. Perforated asbestos-cement pipe shall conform to the requirements of ASTM C508.

2.12 Plastic Pipe. ADD this new section

(a) Smooth Plastic Pipe. Smooth plastic pipe shall have perforated holes in accordance with the requirements of ASTM C444. Smooth plastic pipe shall be made of polyvinylchloride or acrylonitrile-butadiene-styrene plastic in accordance with the following requirements.

1. **Polyvinylchloride (PVC) Pipe.** PVC pipe shall conform to the requirements of ASTM D3033 or D3034, except pipe stiffness for 6-inch nominal diameter pipe not be less than 30 psi at 5 percent deflection and the requirements for joint tightness shall not apply.

2. **Acrylonitrile-Butadiene-Styrene (ABS) Pipe.** ABS pipe shall conform to the requirements of ASTM D2751, SDR 35 sewer pipe, except that the requirements for joint tightness shall not apply.

(b) **Corrugated Plastic Tubing.** Corrugated plastic tubing shall be slotted. The length of the individual slots shall not exceed 10 percent of the nominal inside circumference of the tubing and the width of the slots shall not exceed 1/8 inch. The slots shall be located in the valley of the corrugations and shall provide a minimum inlet area per unit length of pipe equal to 0.75 percent of a cylindrical surface having the same diameter as the nominal inside diameter of the tubing. The slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length of the pipe in rows. The perforation rows shall be spaced around the circumference of the tubing.

Corrugated plastic tubing shall be made of polyethylene (PE) or polyvinylchloride (PVC) plastic and shall conform to the requirements for Heavy-Duty Tubing of ASTM F405 except that the basic material for use in fabricating PVC tubing shall be a PVC plastic meeting the requirements as specified in ASTM D3033.

2.13 Geotextile for Pipe Wrap. Geotextiles for pipe wrap shall weigh at least 3.5 ounces per square yard in the condition of use and shall meet the requirements of AASHTO M 288, with the following modifications to the values listed in Table 1:

The minimum requirements for Tensile Strength is reduced from 125 to 100 lbs.

The range for Equivalent Opening Size (E.O.S.) is increased from 70-100 to 70-120 (U.S. Standard Sieve Size).

The minimum requirement for Coefficient of Permeability is increased from 0.01 to 0.03 cm/sec.

The minimum requirement for Flow Rate is increased from 40 to 100 gal/min. $ft.^2$.

For pipe wrap where the backfill being used around the pipe is Granular Material Class II or better, knitted polyester geotextiles having an E.O.S. of 20 or less, weighing at least 3.0 ounces per square yard in the condition of use, and meeting the other requirements of AASHTO M 288 as modified above, will be permitted as an alternative pipe wrap.

Geotextiles shall be stored and handled carefully and in accordance with the manufacturer's recommendations. Torn or punctured geotextiles shall not be used unless repaired to the satisfaction of the Engineer.

2.14 Mortar. Mortar for pipe connections to other drainage structures shall be composed of 1 part, by volume, of portland cement and 2 parts of

mortar sand. The portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C-6.

2.15 Porous Backfill. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall also conform to particle size specified.

	Percentage By Weight Passing Sieves	
Sieve Designation (Square Openings)	Porous Material No.1	Porous Material No. 2
3" (75 mm)		100
2" (50 mm)	100	
1" (25 mm)		60-100
½" (12.5 mm)	45-85	
No. 4 (4.75 mm)	20-85	
No. 30 (0.60 mm)	5-30	
No. 100 (0.150 mm)		0-30

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

2.16 Bituminous Coating. Bituminous coating of corrugated metal pipe shall conform to the requirements of AASHTO M190.

CONSTRUCTION METHODS

3.1 Equipment. All equipment necessary and required for the proper construction of pipe underdrains shall be on the project, in first-class working condition, and approved by the Engineer before construction is permitted to start. The Contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the pipe bed and backfill, as specified.

3.2 Excavation. The Contractor shall do all necessary excavation to the depth shown on the plans. The excavation shall be unclassified and shall be performed regardless of the material encountered.

When rock or noncushioning material is encountered in trench excavation, a cushion at least 4 inches thick shall be placed between the rock and the bottom of the pipe. The cushion shall consist of clean sand or equivalent granular material. The cost of furnishing and placing the cushion material shall be included in the bid price per linear foot of pipe. When rock is encountered, the bottom of the trench shall be excavated to a horizontal section as far as is practicable.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Engineer. The excavation shall not be carried below the required depth; when this is done, the trench shall be backfilled at the Contractor's expense with material approved by the Engineer and compacted to the density of the surrounding earth material, as determined by the FAA compaction control tests T-611.

The depth of cut shown on the plans is from the surface grade to the invert of the pipeline. In case the depth of cut is changed from that shown on the plans, the change shall not exceed 6 inches without a revision in the contract unit price per linear foot of pipe. However, if the depth of cut is changed more than 6 inches, compensation or deduction of work involved, whether increased or decreased, shall be provided for in a supplemental agreement.

The minimum width of the trench at the top of the pipe, when placed, shall be a width which will permit the proper construction of joints and compaction of backfill around the pipe, but shall be at least equal to the outside diameter of the pipe plus 6 inches on each side of the pipe.

The bed for the pipe shall be so shaped that at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the

pipe bell shall be excavated accurately to size to clear the bell so that the barrel supports the entire weight of the pipe.

The Contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the backfill to at least 12 inches over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench well and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot for the pipe.

3.3 Laying and Installing Pipe.

(a) **Clay or concrete types of pipe.** The Contractor shall provide the necessary mason's lines and supports to insure installation of the pipe to line and grade, as staked by the Engineer. The Contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor the trench will be damaged or disturbed.

The Engineer shall inspect all pipe before it is laid, and reject any section that is damaged by handling or is defective to a degree which will materially affect the function and service of the pipe.

The laying of the pipe in the finished trench shall be started at the lowest point and laid upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid without extra compensation.

(b) **Metal, fiber, or asbestos-cement types of pipe.** The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

The sections of bituminized-fiber pipe shall be securely fastened together with suitable fittings. When the fiber couplings are tapered, they shall provide a tight, driven fit.

The sections of asbestos-cement pipe shall be securely fastened together with suitable couplings. The use of plastic couplings with asbestos-cement underdrain pipe shall provide a permanently tight joint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

(c) **All types of pipe.** The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the Engineer.

Unless otherwise shown on the plans, a 4-inch bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

3.4 Mortar. The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

3.5 Joints in Clay or Concrete Pipe. When **open or partly open joints are required or**

specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, hemp, oakum, or mortar, whichever is specified, shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches nor more than 6 inches, unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2, as shown on the plans or as directed by the Engineer.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the Engineer.

3.6 Backfilling.

(a) **Earth.** All trenches and excavations shall be backfilled within a reasonable time after the pipes are installed, unless other protection of the pipe is directed. The backfill material shall be selected material from excavation or borrow; material which is placed within a nominal pipe diameter distance at the sides of the pipe and 1 foot over the top shall be material which can be readily compacted. It shall not contain stones retained on a 3 inch sieve, frozen lumps, chunks of highly plastic clay, or any other material which is objectionable to the Engineer. The material shall be moistened or dried, if necessary to be compacted by the method in use. Backfill material shall be approved by the Engineer. Special care shall be taken in placing the backfill. Great care shall be used to obtain thorough compaction under the haunches and along the sides to the top of the pipe.

The backfill shall be placed in loose layers not exceeding 6 inches in depth under and around the pipe, and not exceeding 8 inches over the pipe. Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the Engineer, until the trench is completely filled and brought to the proper elevation. Backfilling shall be done in a manner to avoid injurious top or side pressures on the pipe.

In embankments and for other areas outside of pavements, the backfill shall be compacted to the density required for embankments in unpaved areas under item P-152. Under paved areas, the subgrade and any backfill shall be compacted to the density required for embankments for paved areas under item P-152.

(b) **Granular material.** When granular backfill is required, its placement in the trench and about the pipe shall be as shown on the plans. Special care shall be taken in placing the backfill. The granular backfill shall not contain a damaging amount of foreign matter, nor shall earth from the sides of the trench or from the windrow be allowed to filter into the backfill. When required by the Engineer, a template shall be used to properly place and keep separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches in depth and compacted by hand and pneumatic tampers to the requirements as given for earth backfill. Backfilling shall be done in a manner to avoid injurious top or side pressure on the pipe. The granular backfill shall be made to the elevation of the trench, as shown on the plans.

When perforated pipe or cradle invert pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

When porous backfill is to be placed in paved or adjacent areas prior to the completion of grading or subgrade operations, the backfill material shall be placed immediately after laying the pipe. The depth of this granular backfill shall be not less than 12 inches, measured from the top of the underdrain. During subsequent construction operations, this minimum backfill of 12 inches of depth shall not be disturbed until such time as the underdrains are to be completed. When the underdrains are to be completed, the unsuitable material shall be removed

until the porous backfill is exposed. That part of the porous backfill which contains objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any such unsuitable material shall be borne by the Contractor.

Whenever a granular subbase blanket course is to be used under pavements which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material which remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

3.7 Connections. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

3.8 Cleaning and Restoration of Site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

After all work is completed, the Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

Performance of the work described in this section is not payable directly but shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for the underdrain.

METHOD OF MEASUREMENT

4.1 The footage of pipe to be paid for shall be the number of linear feet of pipe underdrains in place, completed and approved, to be measured along the centerline of the pipe from pipe end or face of end structure to the center of intermediate structures or from center to center of structures, whichever is applicable. No deduction will be made for the width of structure. The several types and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the underdrain being measured. Payment for geotextile pipe wrap shall be included in the unit cost per linear foot of pipe.

BASIS OF PAYMENT

5.1 Payment will be made at the contract unit price per linear foot for **pipe underdrains of the type, class, and size** designated; at the contract unit price per cubic yard for porous backfill No. 1; and at the contract unit price per cubic yard for porous backfill No. 2. These prices shall be full compensation for furnishing all materials and for all preparation, hauling, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for each type of underdrain or porous backfill required per linear foot, or per cubic yard, as applicable.

The first three digits of any item number for work included under this specification shall be 705, i.e. 705XXXX.

TESTING AND MATERIAL REQUIREMENTS

Test and Short Title

FAA T-611 - Density
ASTM D638 - Tensile Properties

Material and Short Title

*WW-P-402	Aluminum Pipe
*WW-P-405	Steel Pipe

ASTM	C700	Clay Pipe
AASHTO	M 190	Bituminous Coating
ASTM	C-6	Lime
ASTM	C144	Mortar Sand
ASTM	C150	Portland Cement
ASTM	C444	Perforated Concrete Pipe
ASTM	C508	Asbestos Cement Pipe
ASTM	C654	Porous Concrete Pipe
ASTM	D2311	Bituminous Fiber Pipe
ASTM	D2751	ABS Pipe
ASTM	D3033	Type PSP PVC
ASTM	D3034	Type PSM PVC
ASTM	F405	Corrugated Plastic Tubing

* Federal Specification

Note: Others as required by referenced specifications.
Cross-referenced specification required: P-152.